

Economic impacts of nutrient loading

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EPA's Sustainable & Healthy Communities Research Program



Nitrogen outside the safe boundary

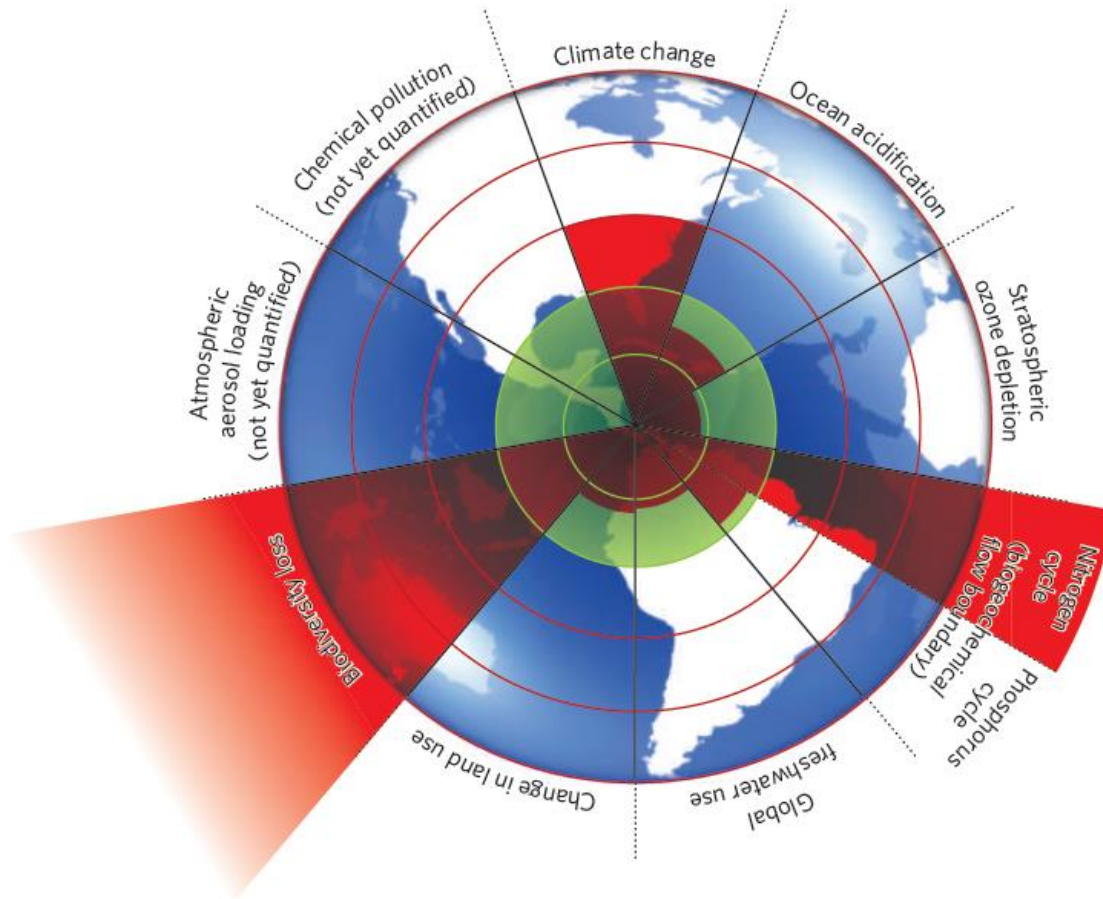


Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

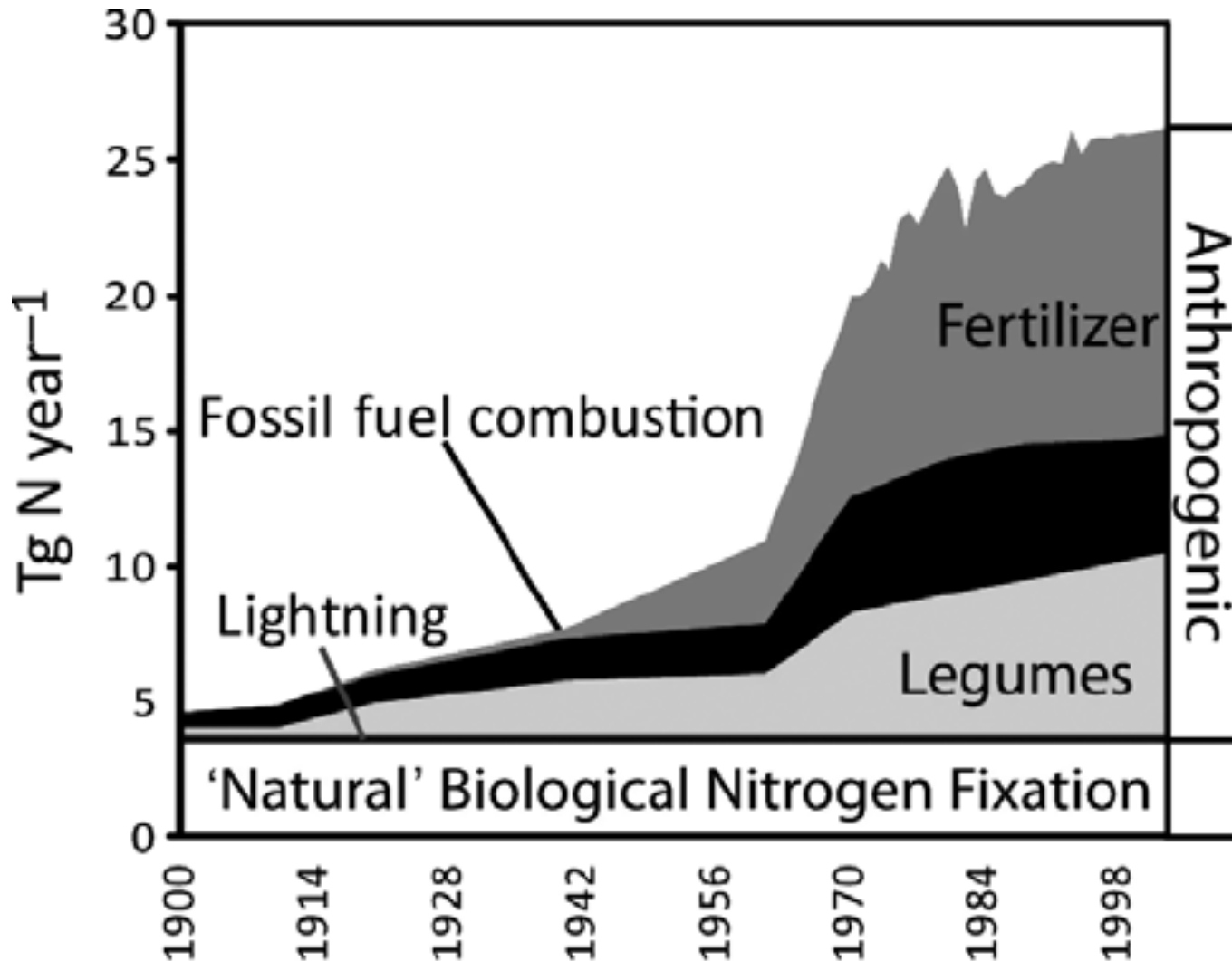
Why Nitrogen and Economics?

- Nitrogen is a critical component of energy, food, and fiber production, benefiting humans in many ways.



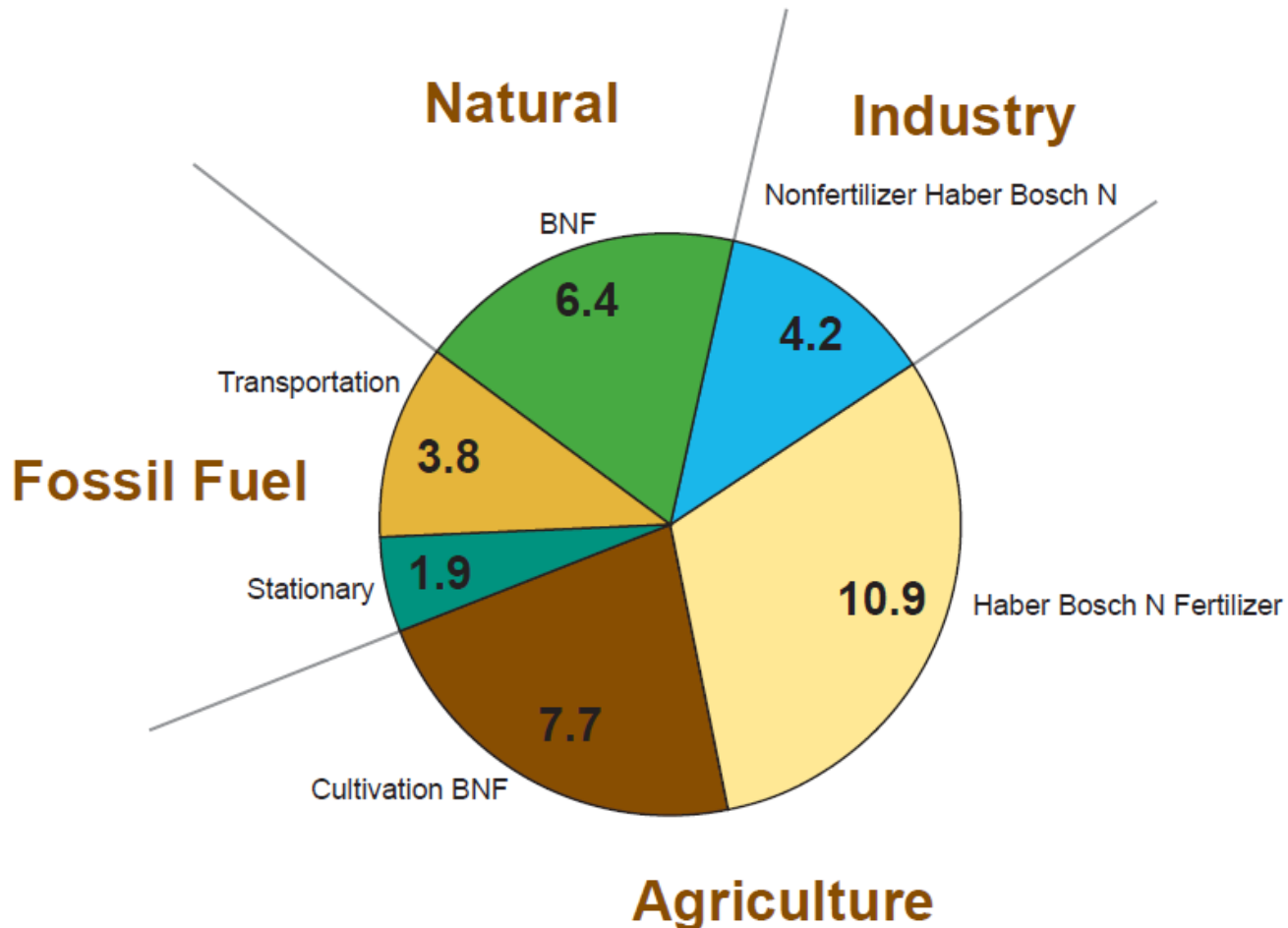
Nitrogen (N) inputs to US

increased 5-fold since 1900

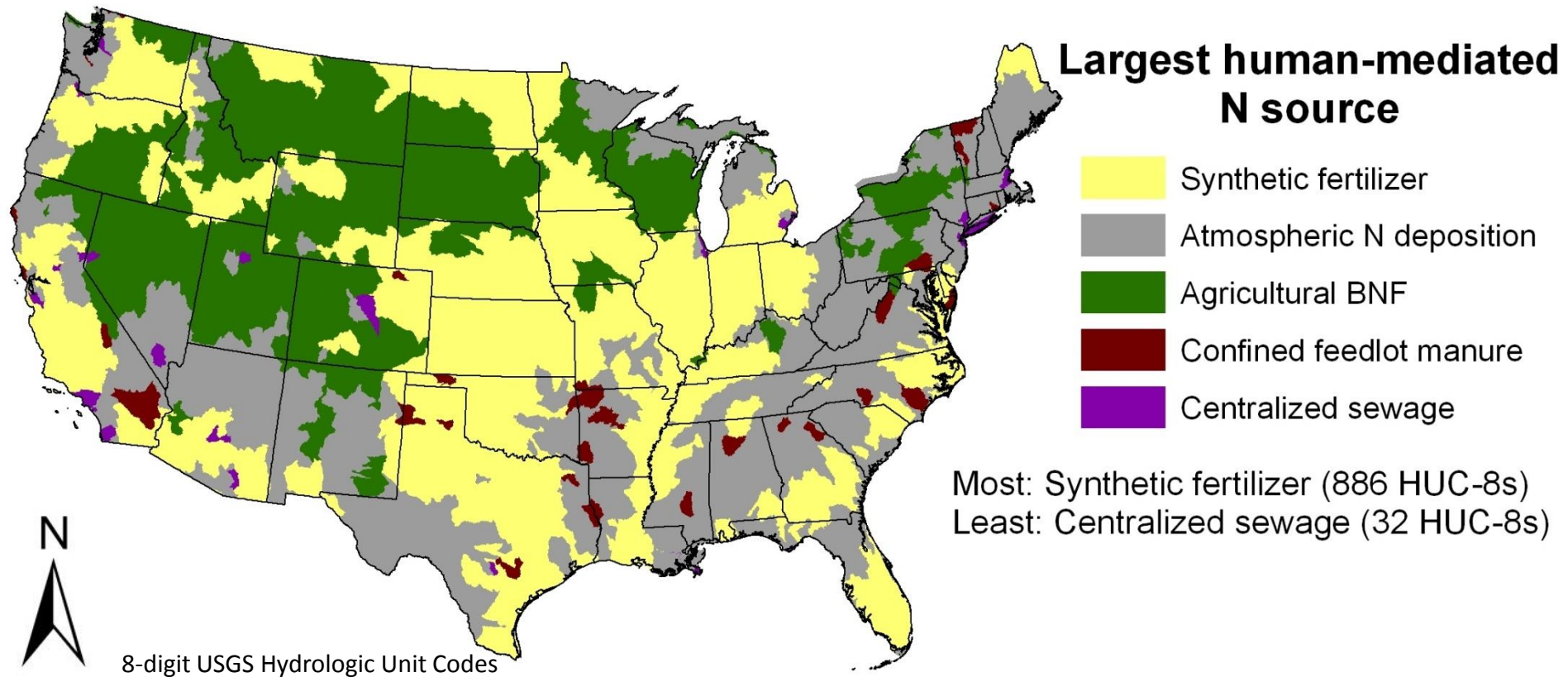


What is the source of this N?

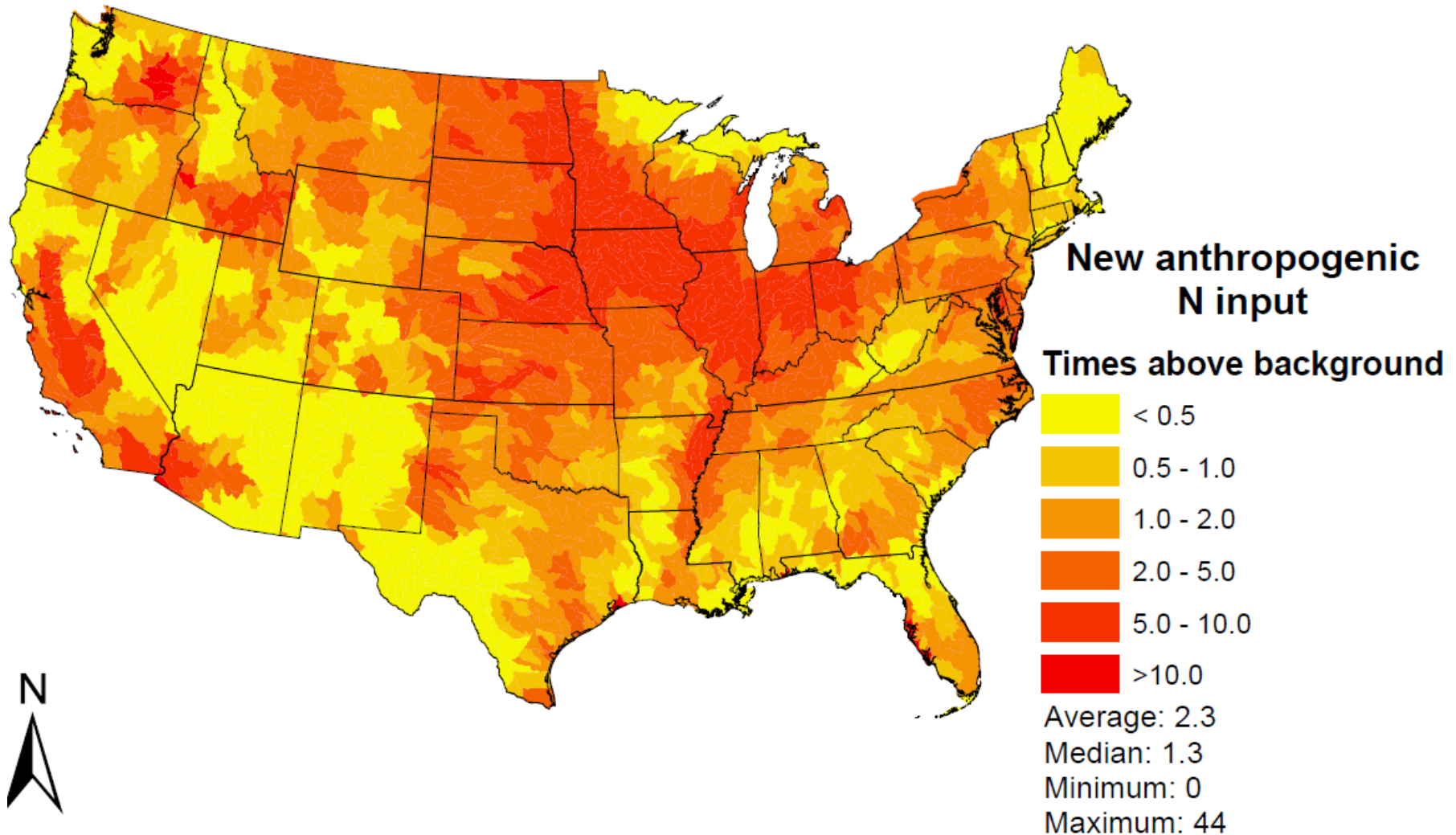
Inputs to the US in 2002 (Tg N/yr)



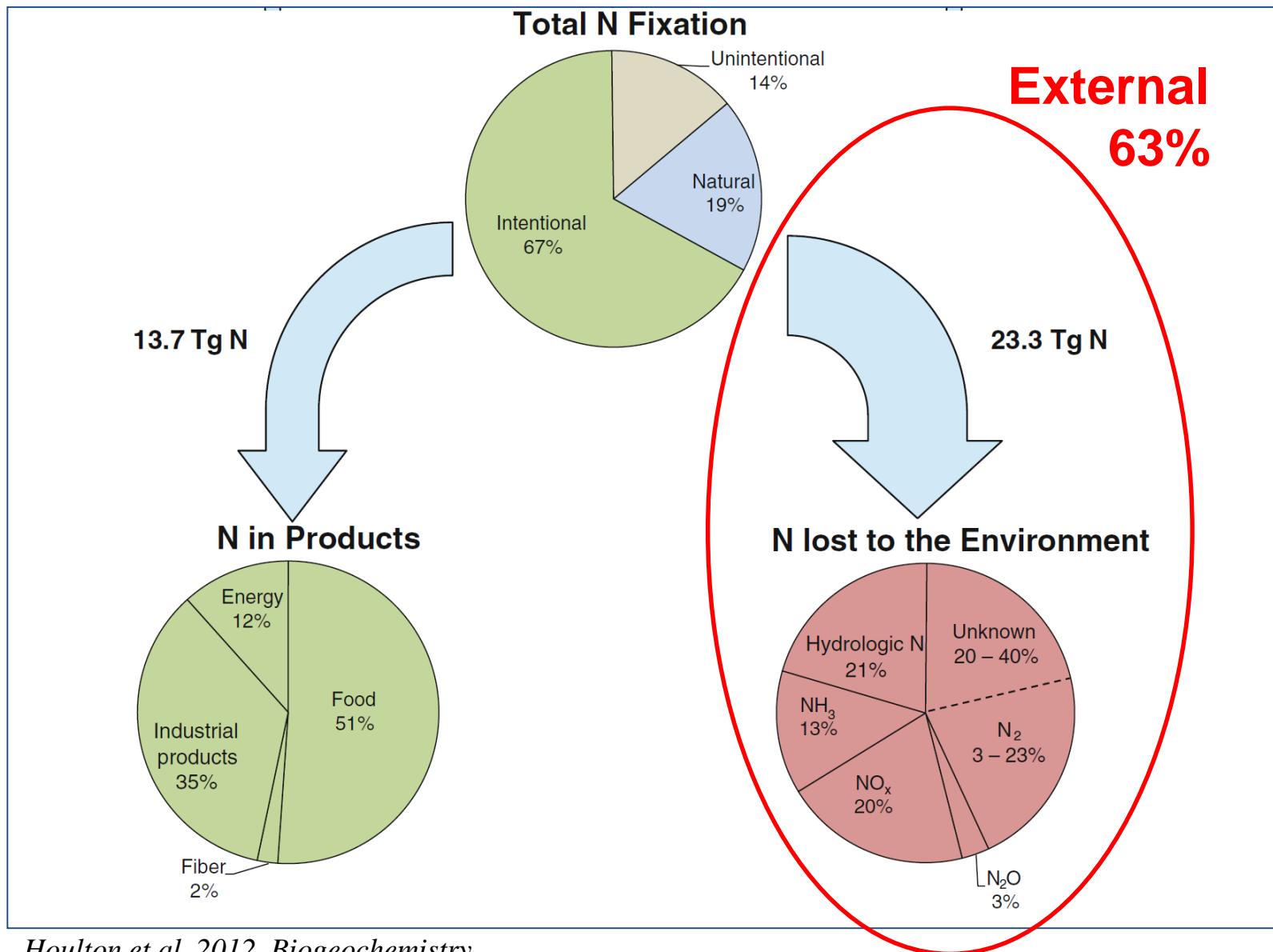
Dominant Human N Source



Where are the largest human inputs?



What happens to the N inputs?



Too Much Nitrogen; Too Many Consequences



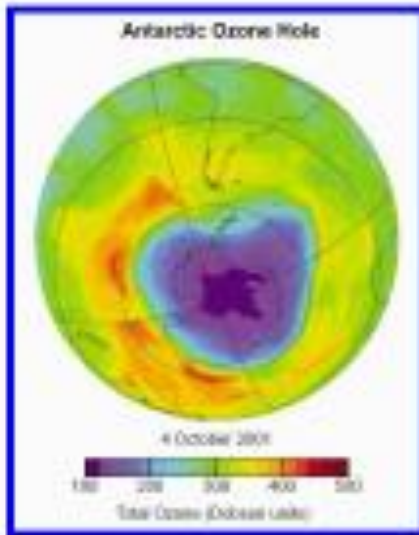
Smog, Haze



Forest Die-back



Acidification



Ozone Hole

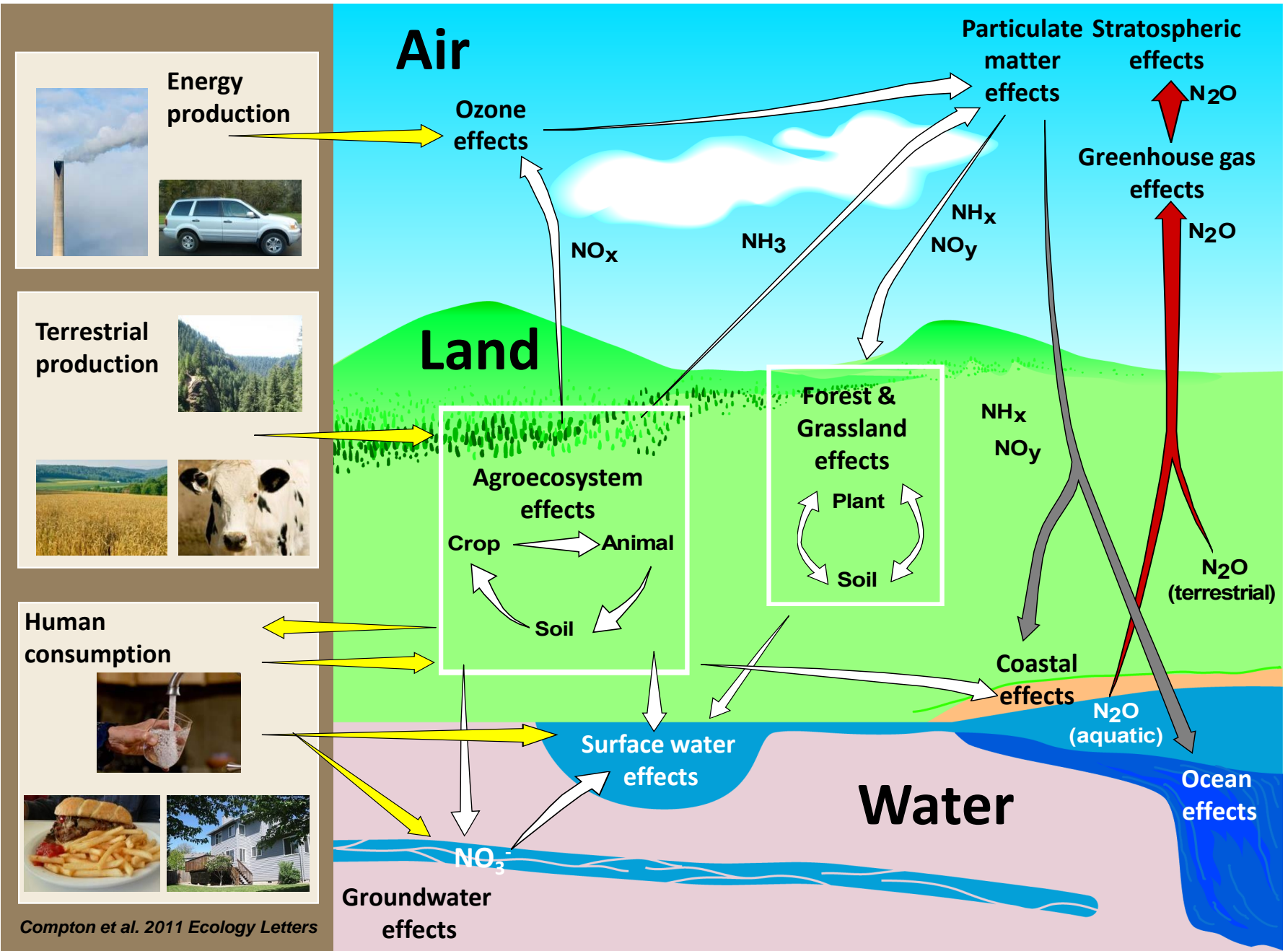


Global Warming



Eutrophication

The nitrogen cascade



National Nutrient Problem Scope

- 14,000 Nutrient-related Impairment Listings in 49 States
 - and this is an underestimate . . .
- Over 53% Have Medium to High Levels of Nitrogen
- Over 47% of Streams Have Medium to High Levels of Phosphorus
- One Third of U.S. Estuaries Eutrophic
- 168 Hypoxic Zones in U.S. Waters

Nutrient impaired coastal waters

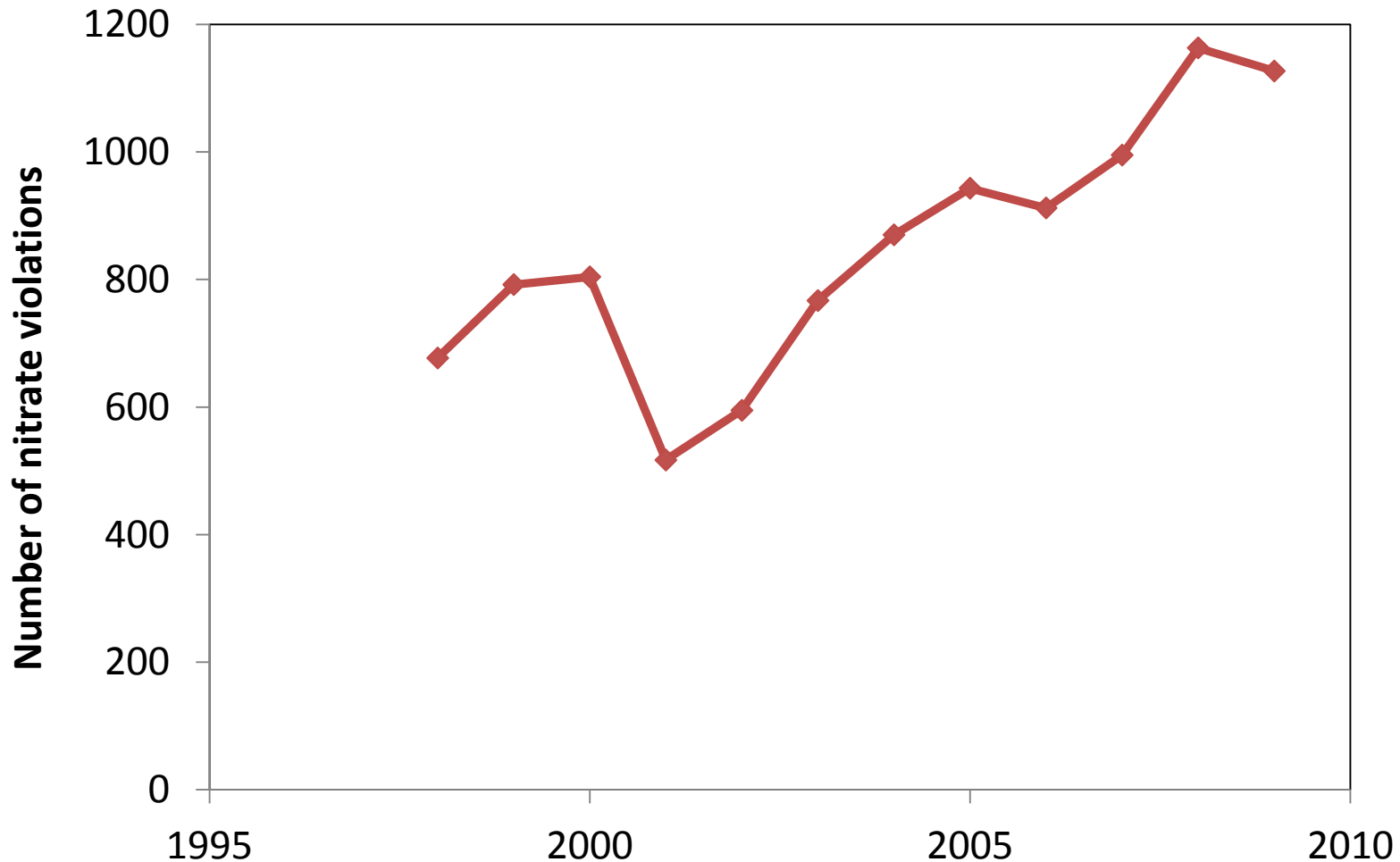


Impaired water body under Clean Water Act Section 303(d) —

Impairments due to nitrogen concentrations, algal growth, noxious aquatic plants, or oxygen depletion under Section 303(d) of the Clean Water Act (US EPA, 2012)

Nitrate violations in drinking water

US Community Water Systems



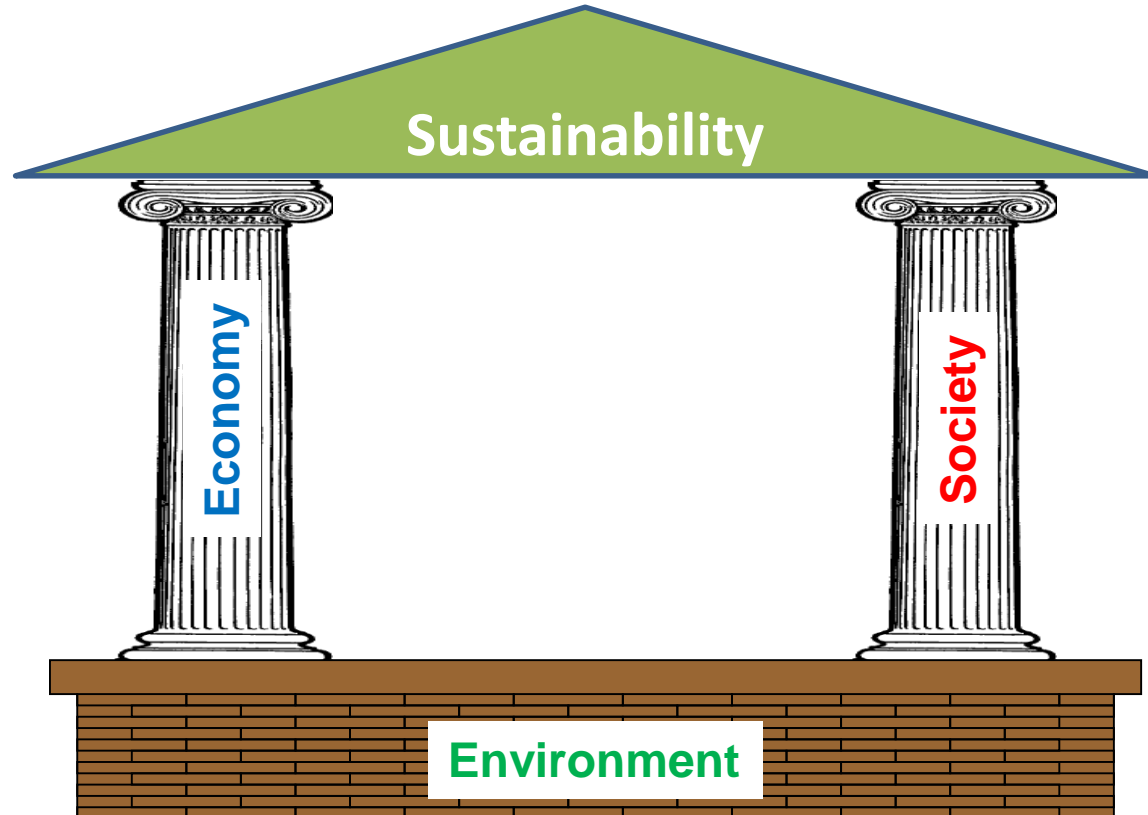
Getting to solutions

- A new approach
 - Bringing in sustainability and ecosystem services
 - New perspectives on old approaches
- Quantify the economic damages associated with nutrients
 - National
 - PNW
- Examine alternative futures for nutrient management

Building a sustainability perspective

(EPA-ORD's Sustainable and Healthy Communities Research Program)

The Ceiling of Environmental Protection



The Floor of Environmental Protection

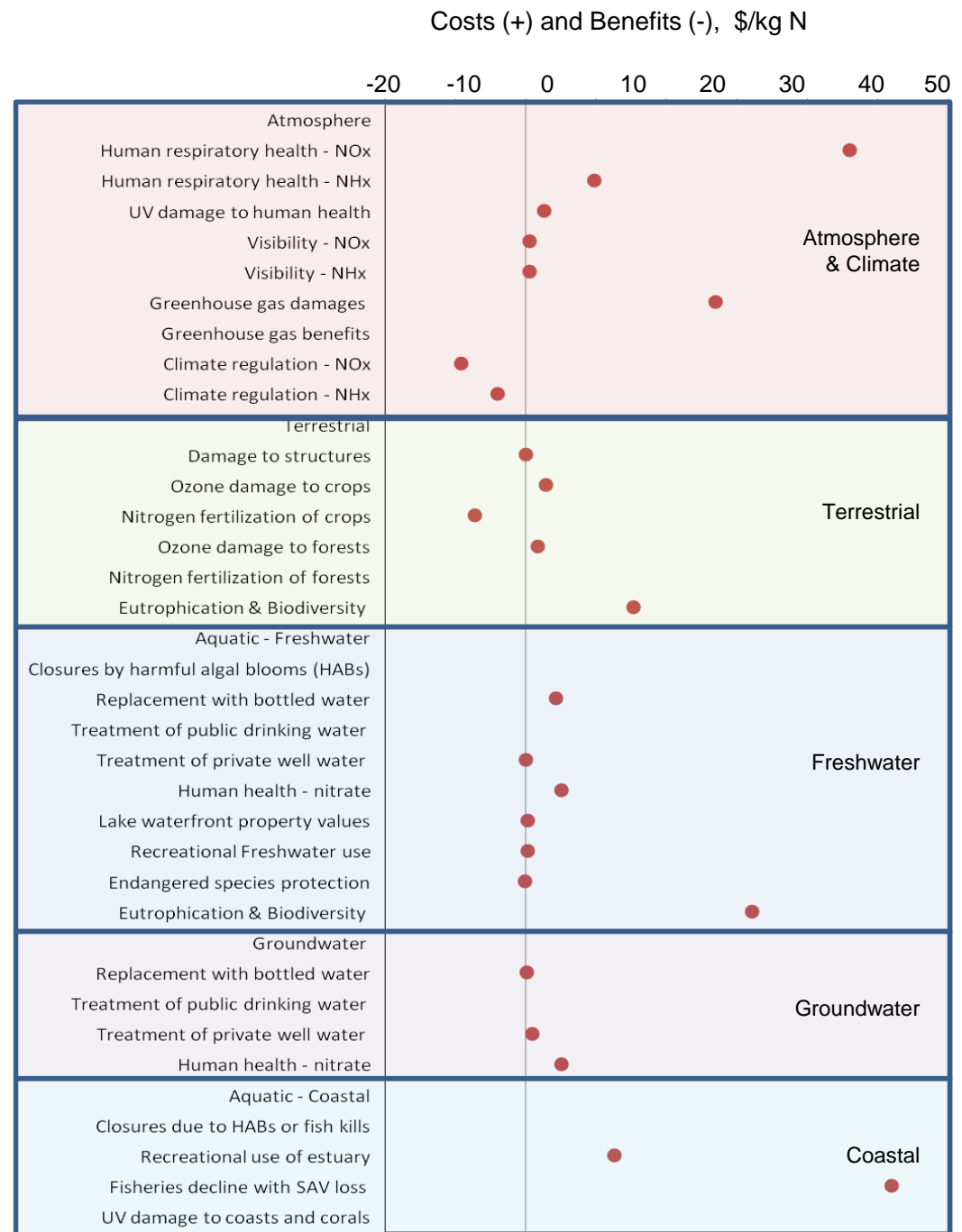
CAA
CWA

The 70 & 80's
Command & Control

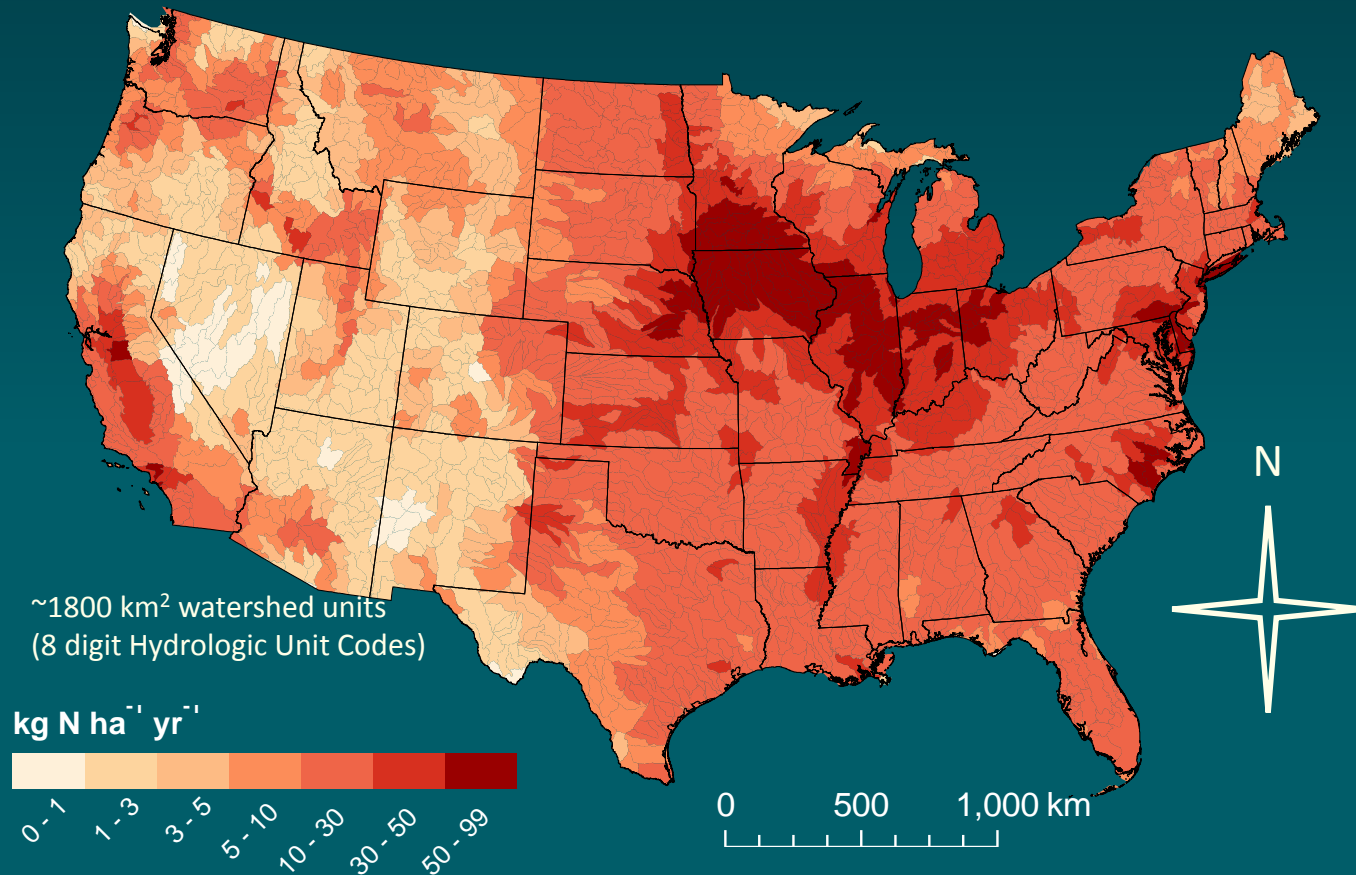
RCRA
CERCLA

Costs of nitrogen pollution

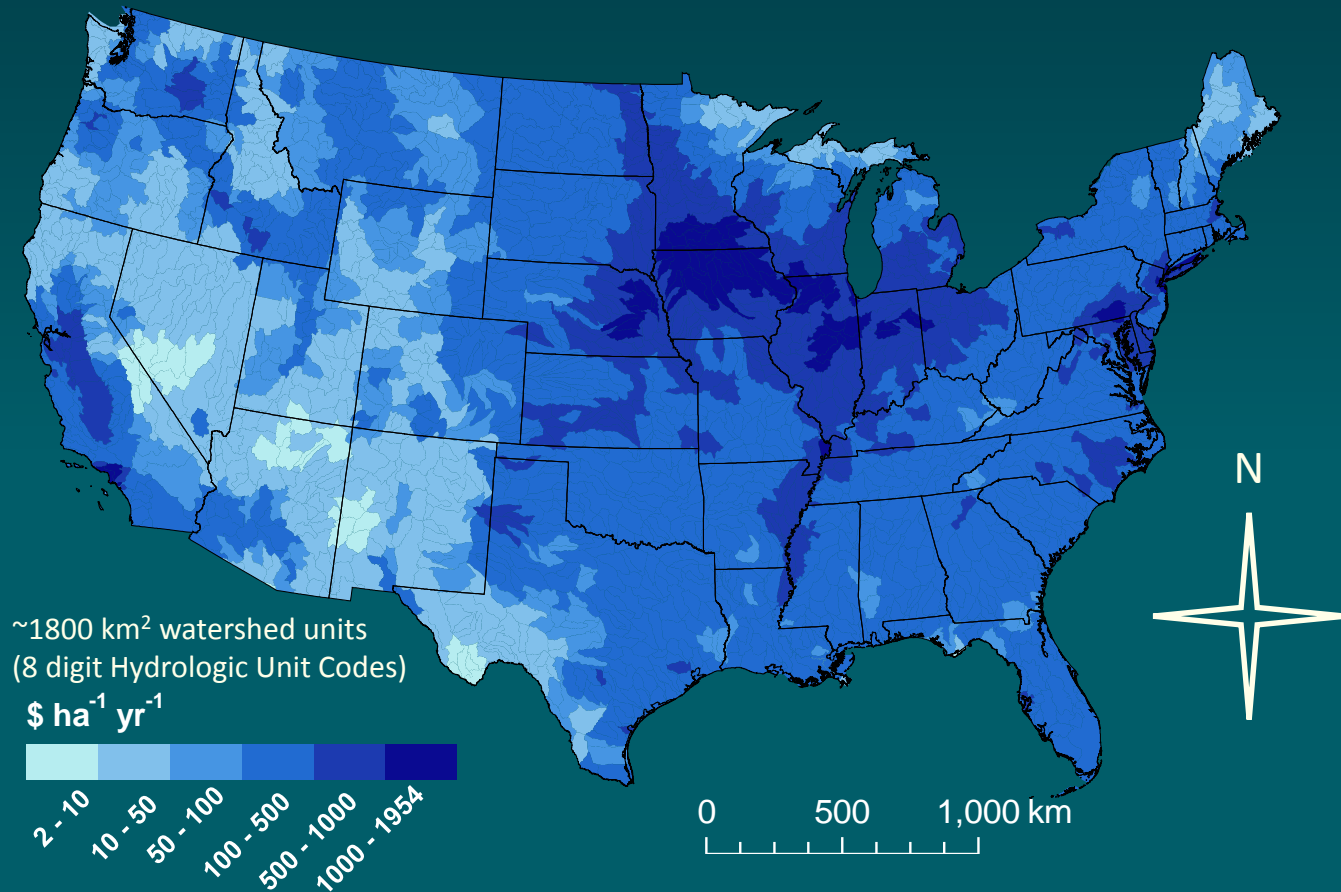
- Human respiratory health
- Freshwater eutrophication
- Damage to seagrasses and fisheries



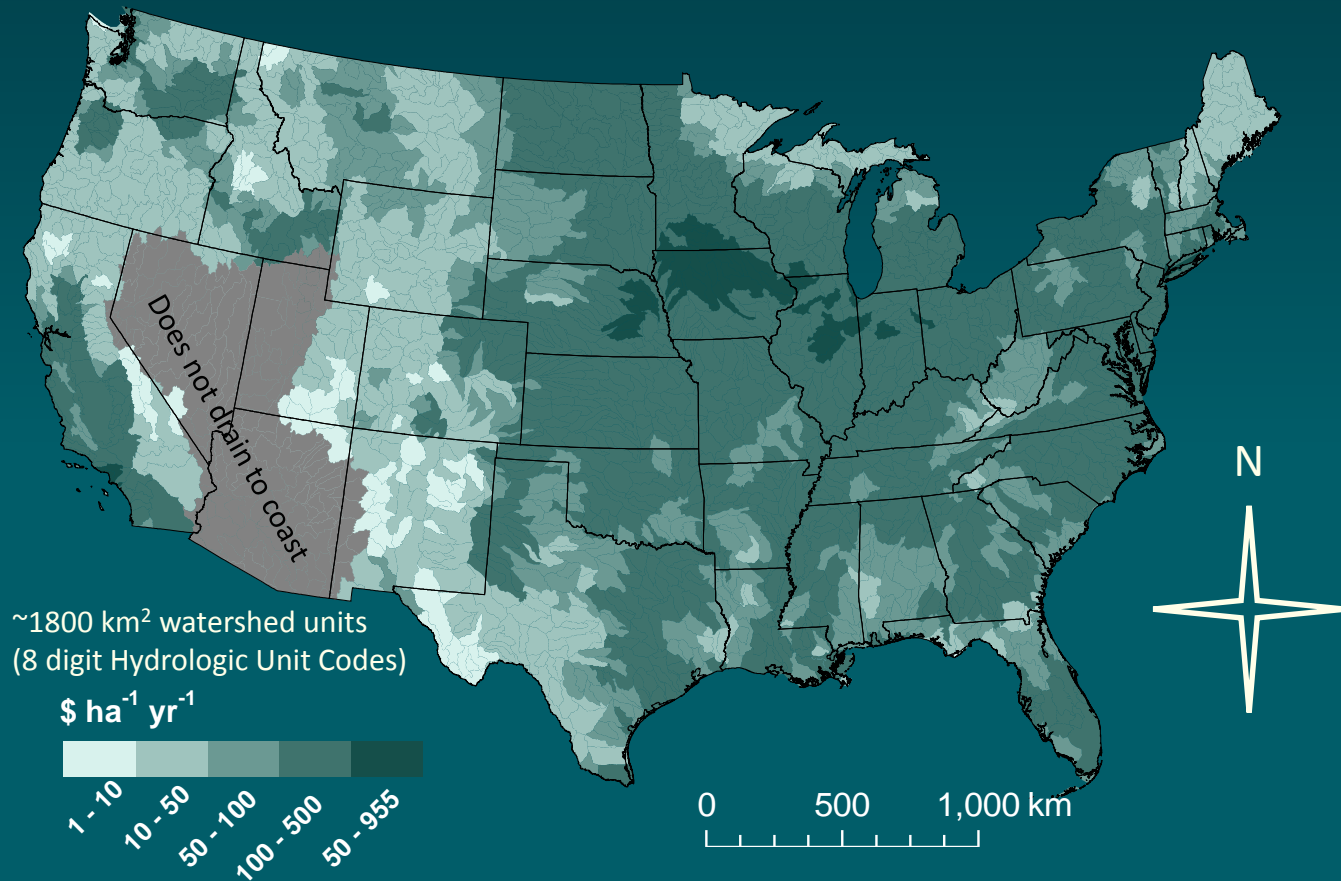
Anthropogenic N loss, circa 2000



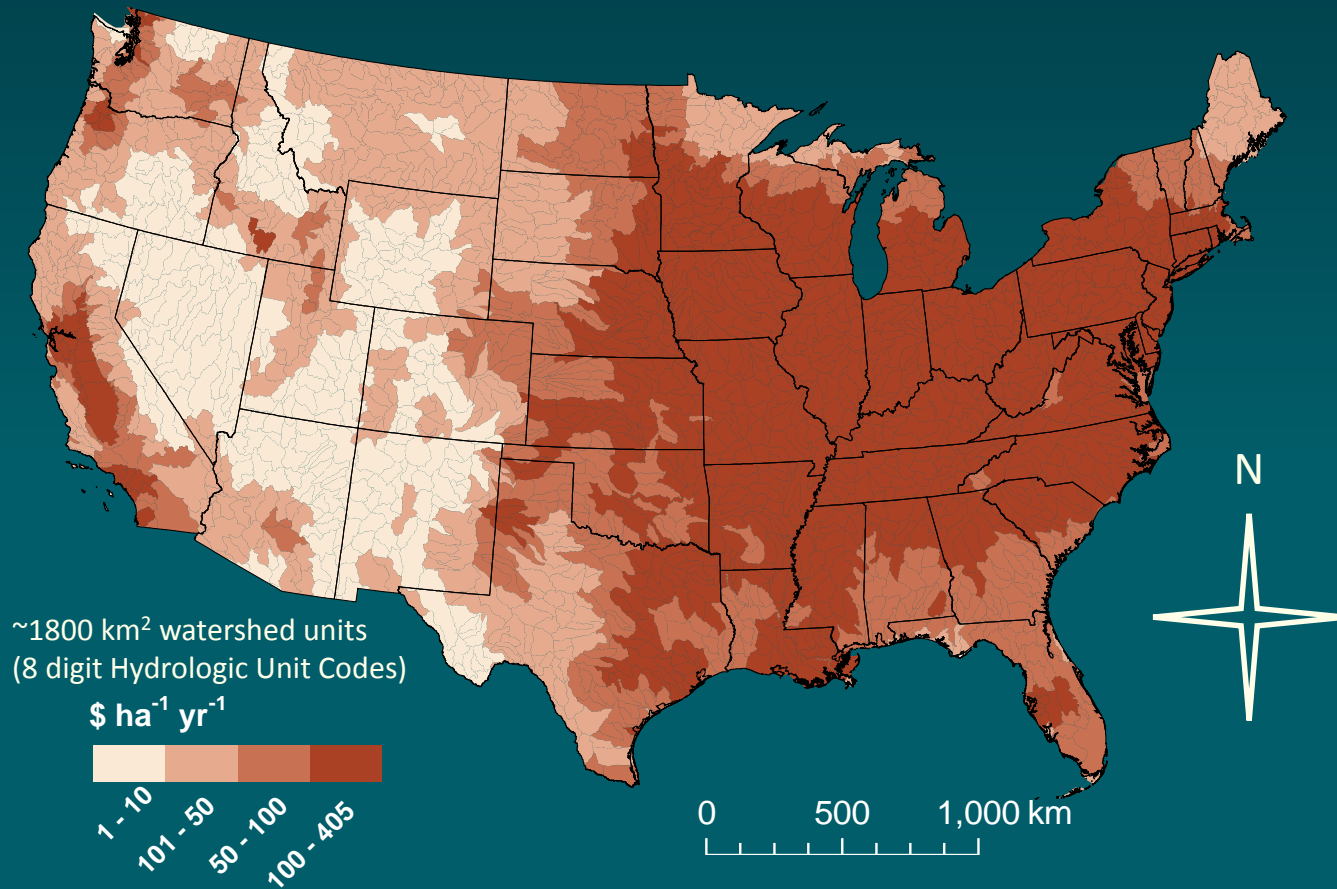
Freshwater damage costs, circa 2000



Coastal damage costs, circa 2000

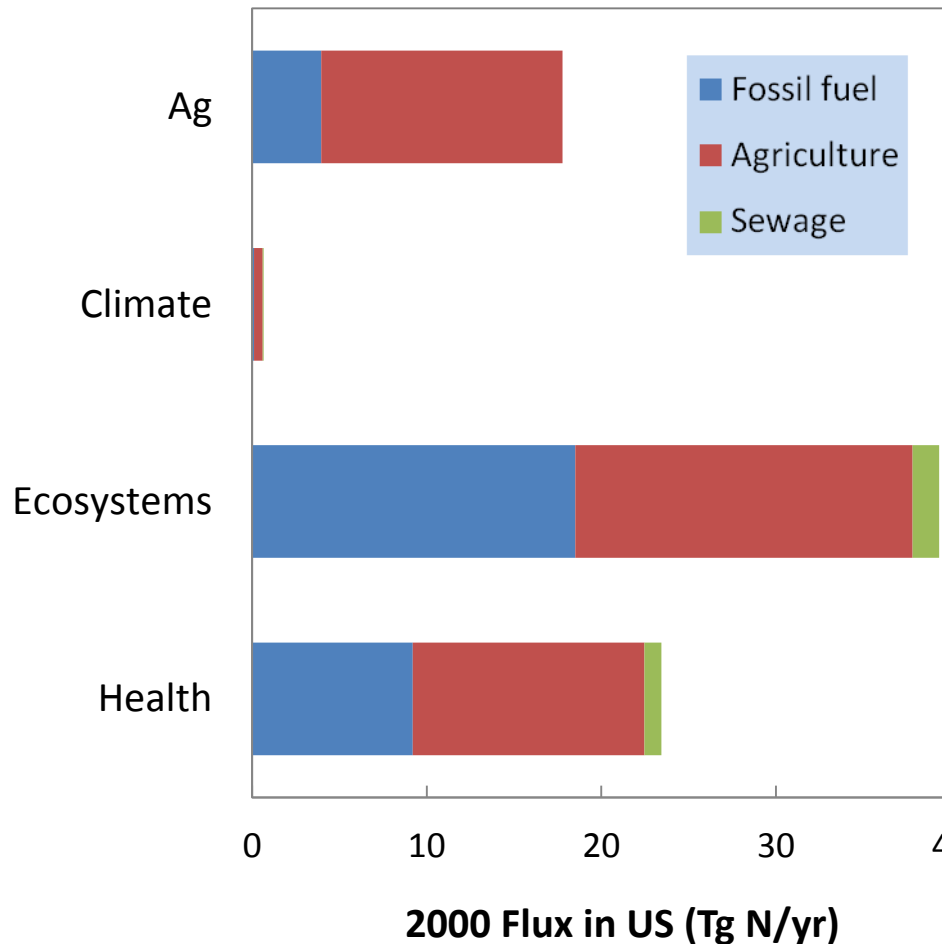


Human health costs, circa 2000

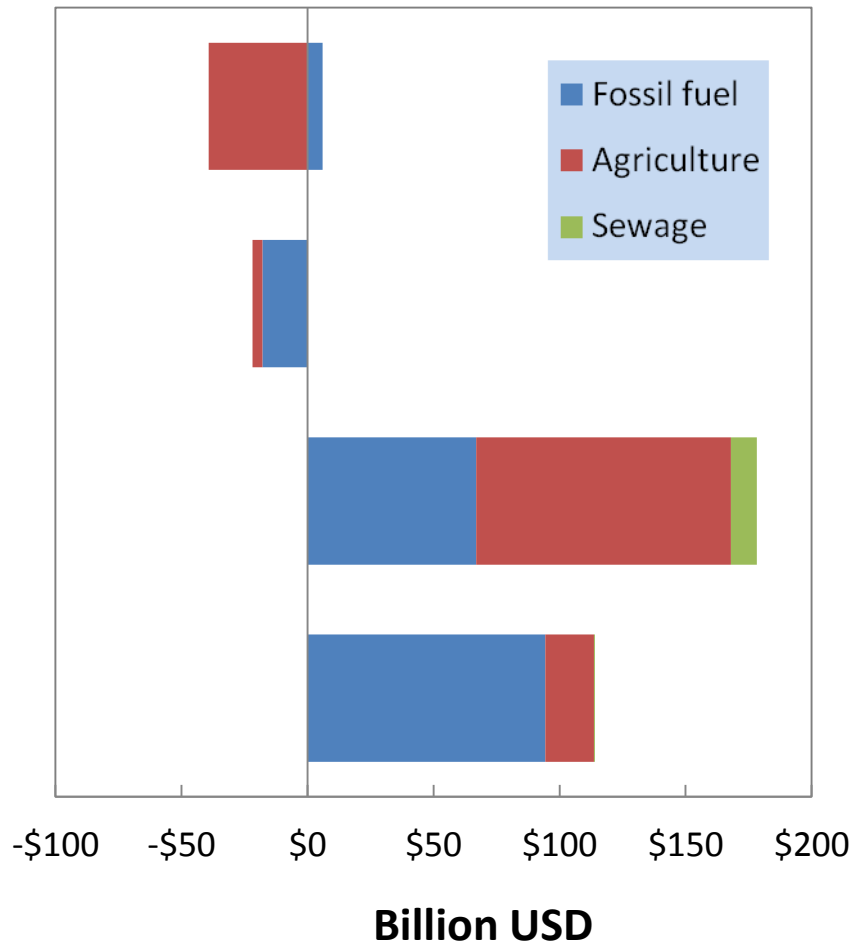


Effects on endpoints by source

Nitrogen Inputs from



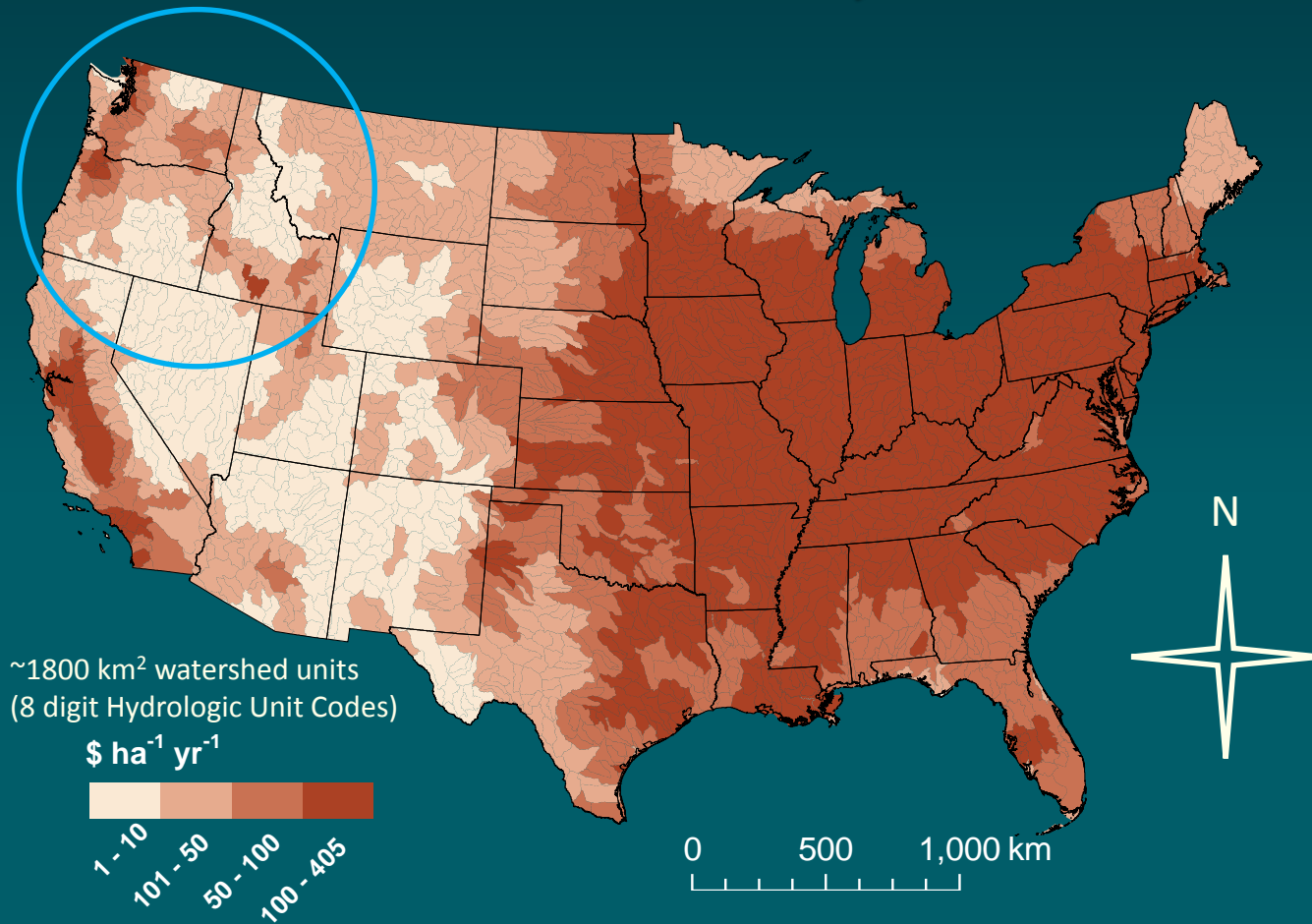
Damages to



PNW-specific economic impacts

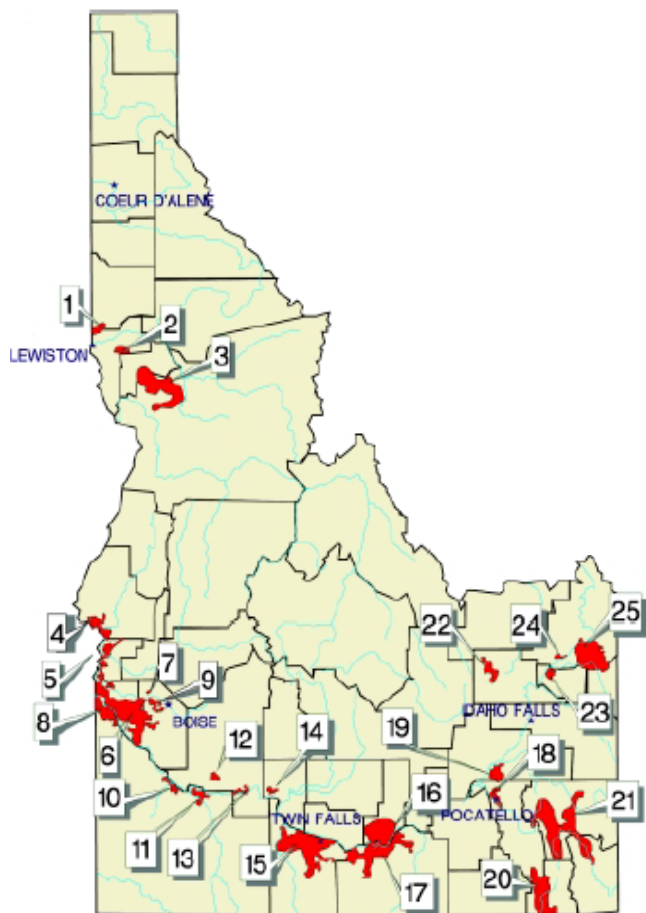
- Algal blooms in lakes
 - Lake Washington first example
 - Current HABs monitoring
- Groundwater nitrate contamination
 - Oregon GWMA: S. Willamette, Umatilla, Owyhee
 - Washington GWMA: Columbia Basin, Lower Yakima
 - Idaho's Nitrate Areas of concern
- Coastal nutrient impairments

Human health costs, circa 2000

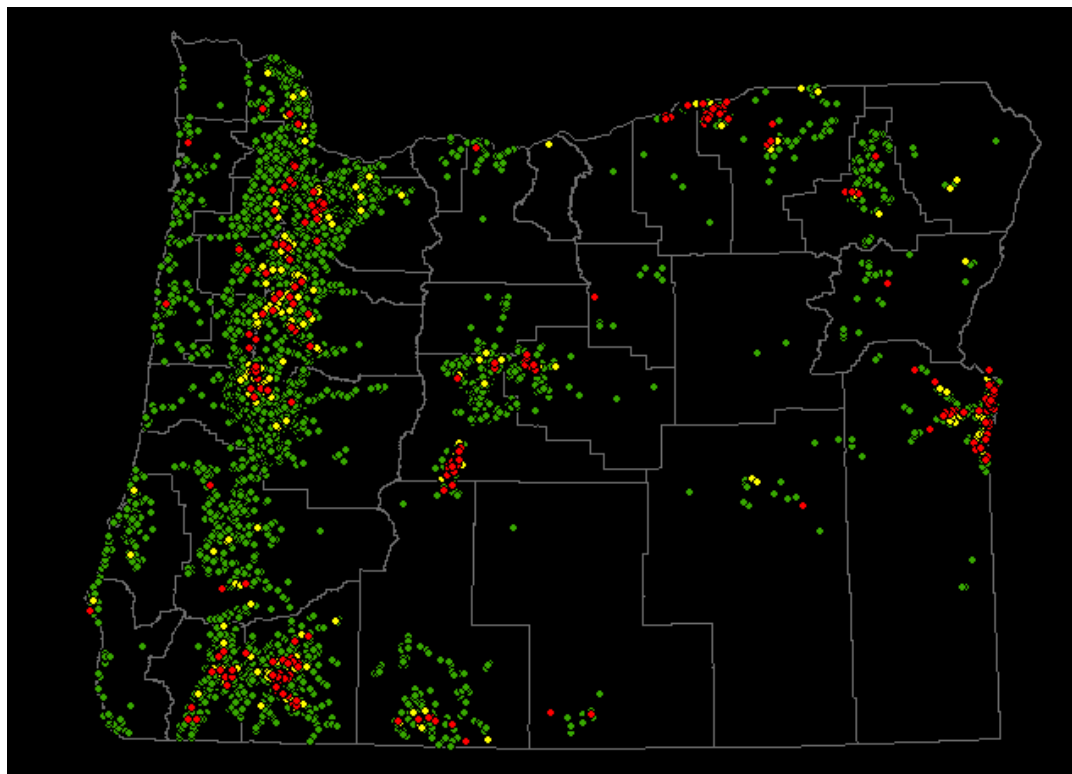


Idaho's Nitrate Areas of Concern

R. L. Mahler and K. E. Keith



Nitrate-N in Oregon residential wells



Real Estate Transaction
database, 1989-2000

*Brenda Hoppe, OSU
and ODHS*

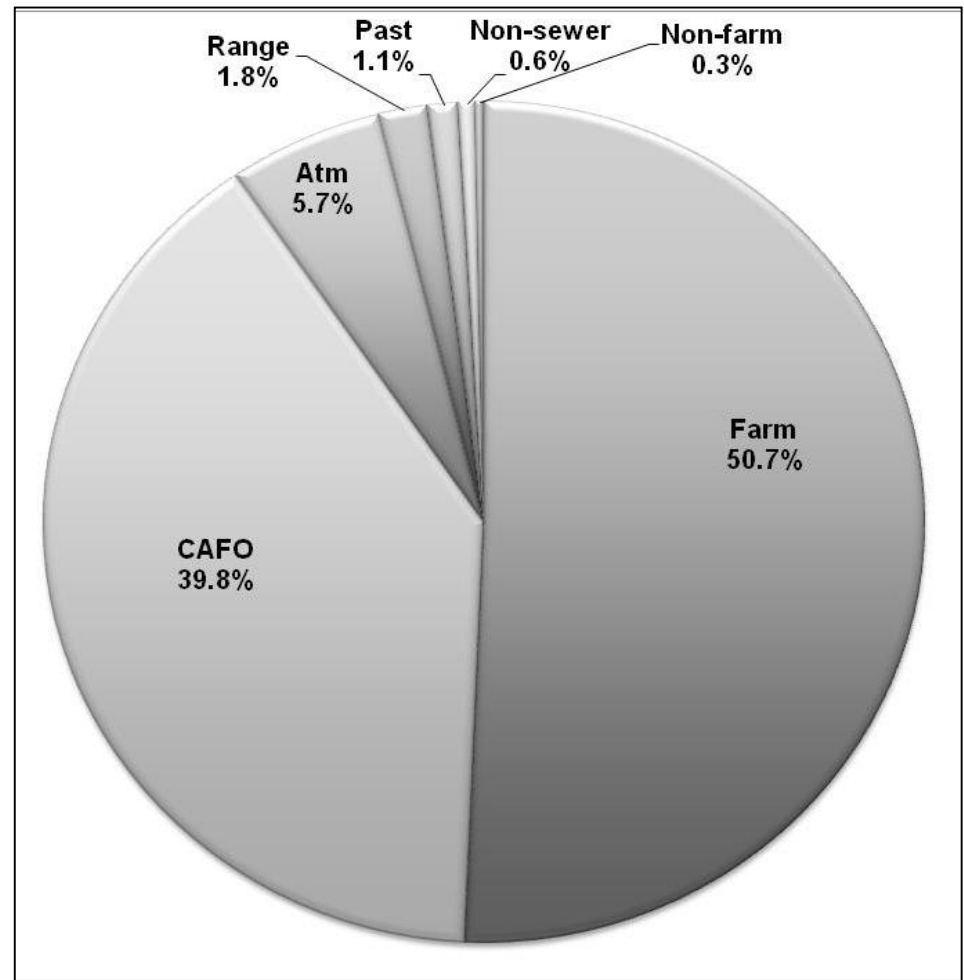
Nitrogen impacts to drinking water in the Lower Yakima River Basin

- \$57 million -> Annual estimate of willingness to pay for drinking water below the MCL for nitrate was.

- Ranged from \$613-911 per household per year.

- Approximately \$160/kg N loading.

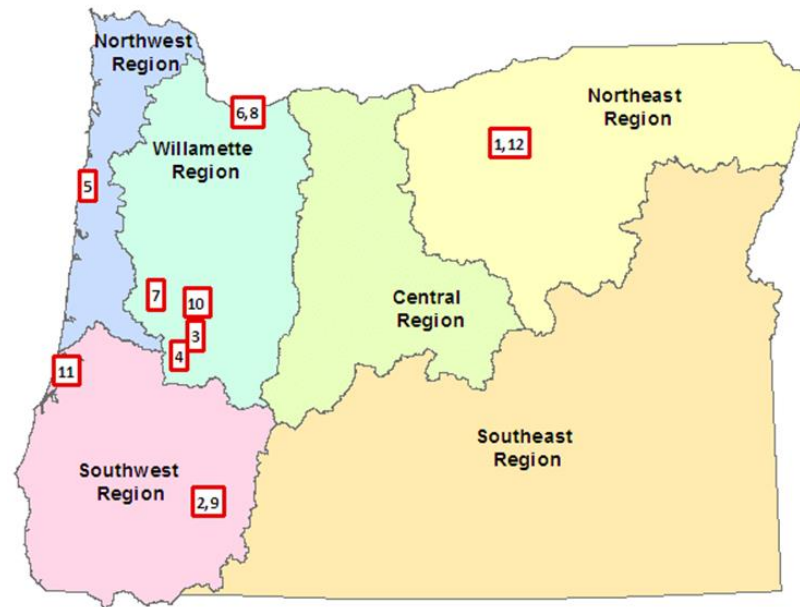
Nitrogen load by source



Harmful Algal Blooms in Oregon

•12 lakes in

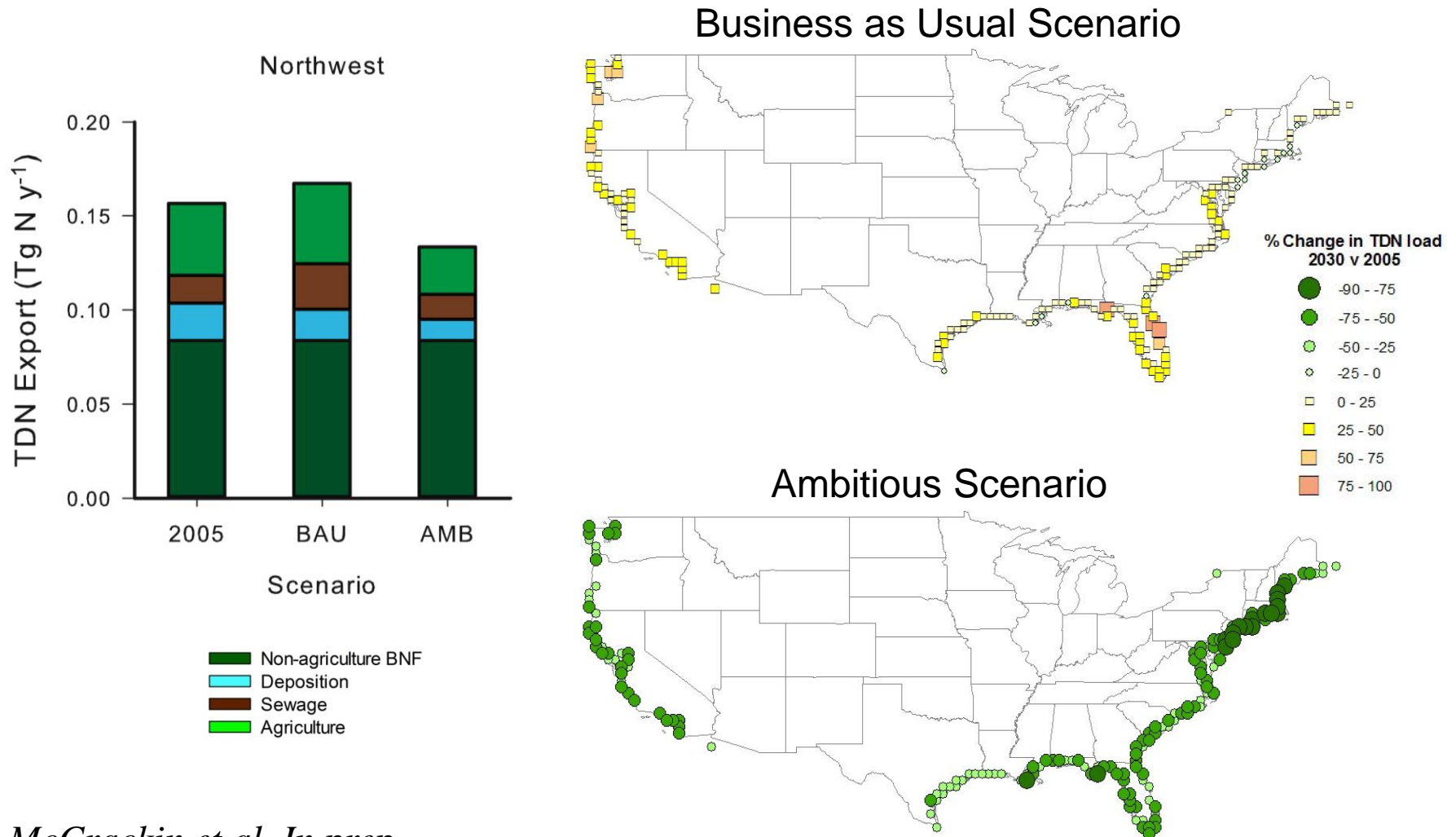
•Funding for the Harmful Algal Bloom Surveillance program ended in 2013.



2013 Advisory Listing

#	Waterbody	Region	County	Dominant Species/Toxin	Cell Count/Level	Start Date	End Date	Duration (days)
1	Willow Creek Reservoir	Northeast	Morrow	Anabaena flos-aquae	3,551,625	6/18/2013	8/13/2013	56
2	Lost Creek Lake	Southwest	Jackson	Anabaena flos-aquae	1,175,333	6/20/2013	7/05/2013	15
3	Dexter Reservoir	Willamette	Lane	Anabaena flos-aquae	2,228,000	7/03/2013	9/19/2013	78
4	Dorena Reservoir	Willamette	Lane	Anabaena flos-aquae	556,000	7/25/2013	9/24/2013	61
5	Devils Lake	Northwest	Lincoln	Microcystis	Unknown	8/01/2013	11/21/2013	112
6	Blue Lake	Willamette	Multnomah	Visible Scum	Unknown	8/06/2013	8/09/2013	3
7	Fern Ridge Reservoir	Willamette	Lane	Visible Scum	Unknown	8/15/2013	12/18/2013	125
8	Blue Lake	Willamette	Multnomah	Visible Scum	Unknown	9/09/2013	9/13/2013	4
9	Lost Creek Lake	Southwest	Jackson	Anabaena flos-aquae	1,032,975	9/13/2013	12/30/2013	109
10	Walterville Pond	Willamette	Lane	Microcystis	46,000	9/13/2013	10/3/2013	20
11	Tenmile Lakes	Southwest	Coos	Microcystis	Unknown-high toxins	10/04/2013	12/03/13	60
12	Willow Creek Reservoir	Northeast	Morrow	Anabaena flos-aquae	1,104,950	10/25/2013	1/21/2014	88

Nutrient reductions possible with improved management



Take home messages

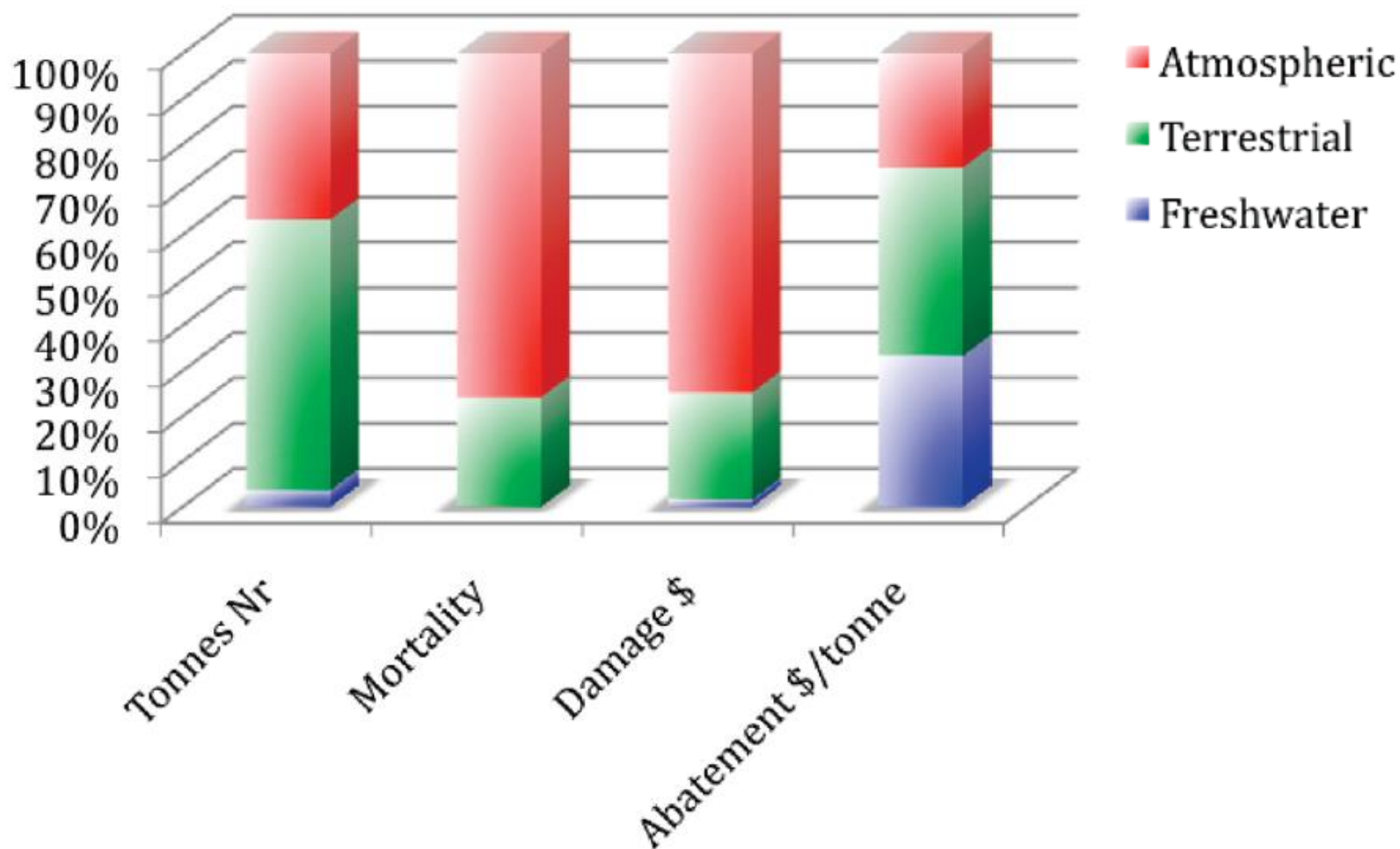
- Human activities increased N to the biosphere by 5-fold in the US.
- 63% of this N is released into the environment.
- Nutrient damage costs are substantial. Human health effects have historically had the highest per kg value, but...
- There are lots of gaps in our assessment, particularly for freshwater and coastal ecosystems.
- We can reduce coastal loading, by improved nutrient use efficiency, waste treatment and continued air quality improvements.

For more information →
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Also see: EPA SAB Integrated nitrogen committee report 2011
EU Nitrogen Assessment 2011
International Nitrogen Initiative website

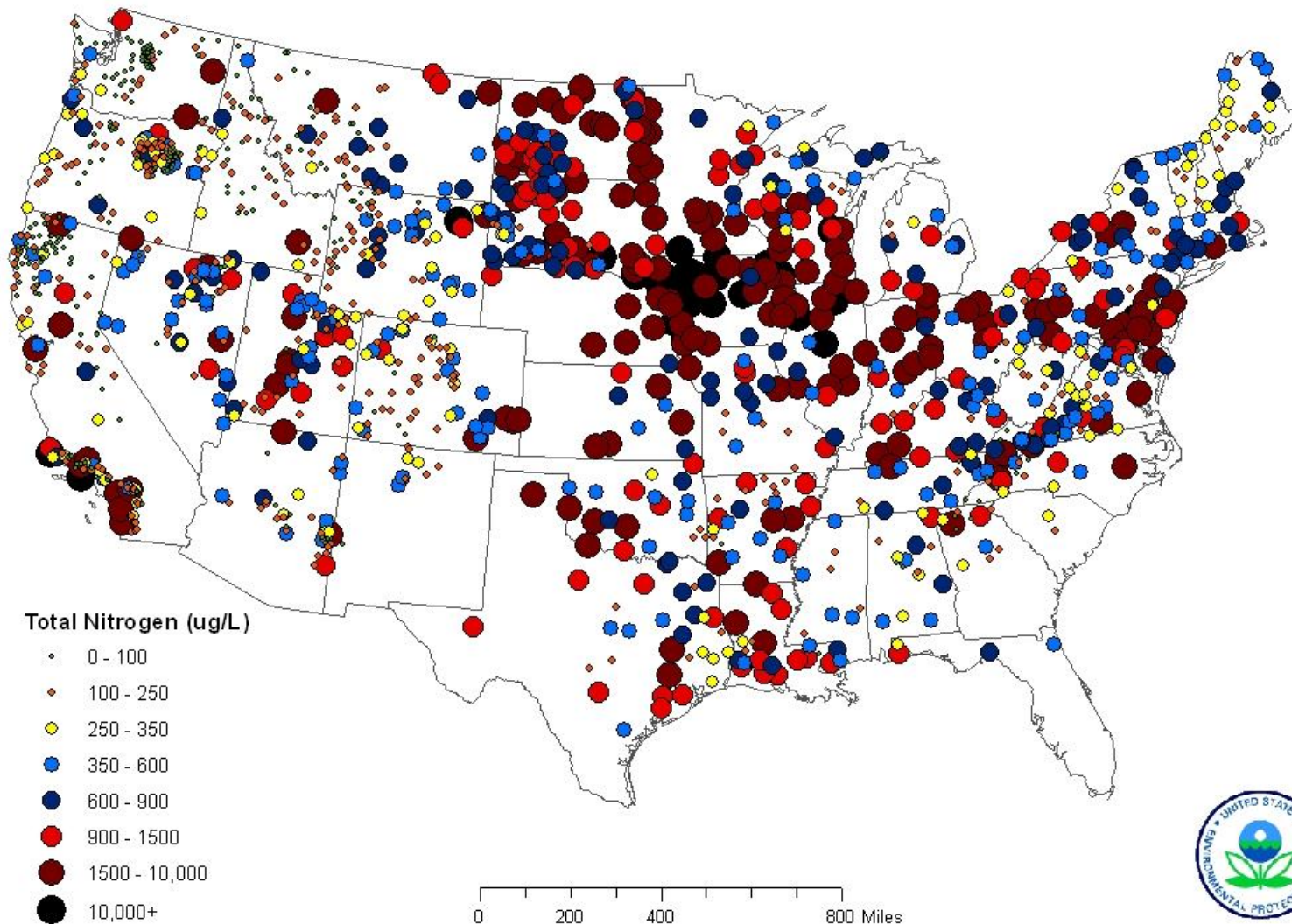


FIGURE 3. Share of contributions from all reactive nitrogen sources in the Chesapeake Bay watershed according to different metrics.

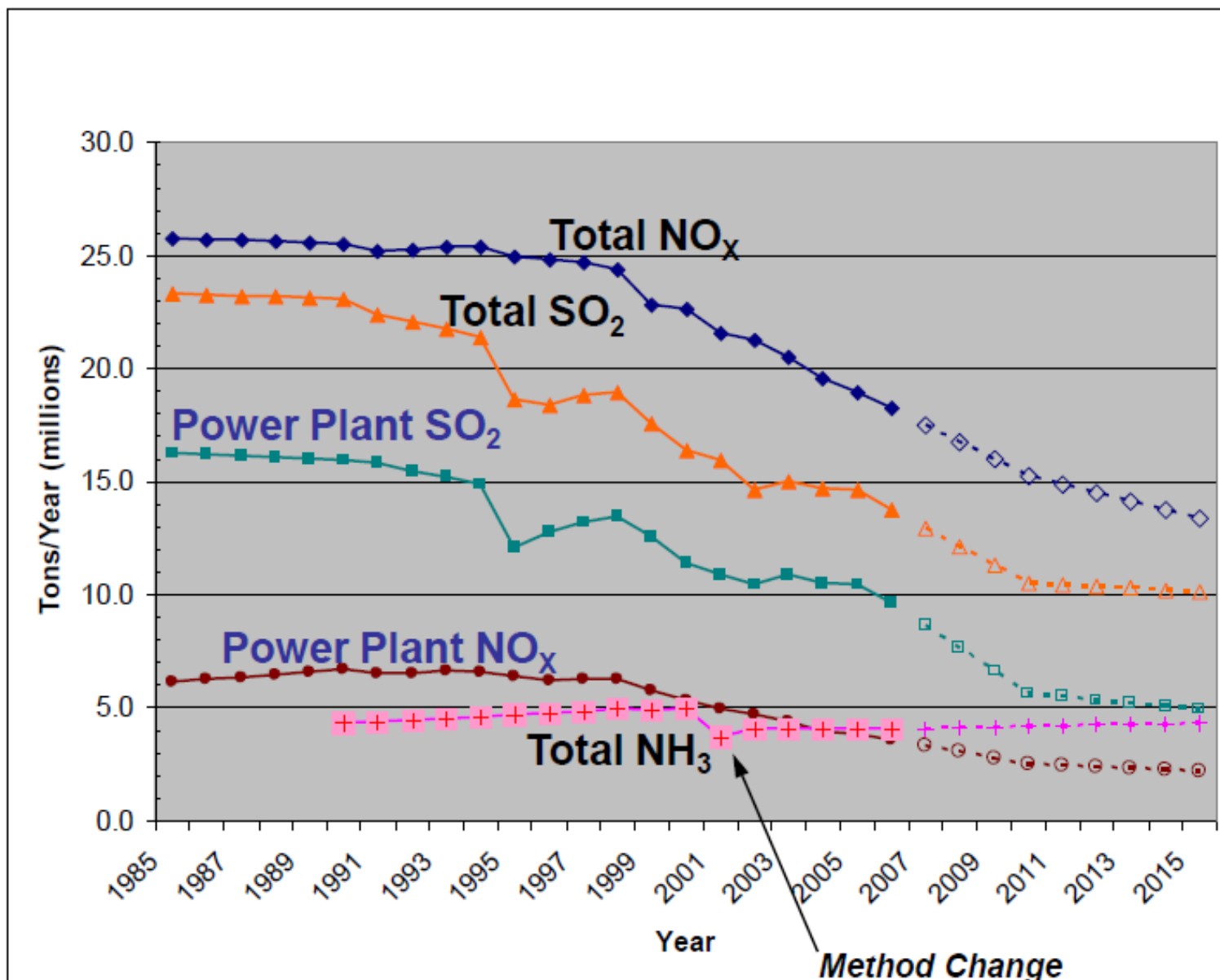


Concentrations of Nitrogen in Streams

US EPA Wadeable Streams Assessment



NO_x, SO₂ and NH₃ National Emissions Trends



Incorporating the Triple Bottom-Line into decision-making

